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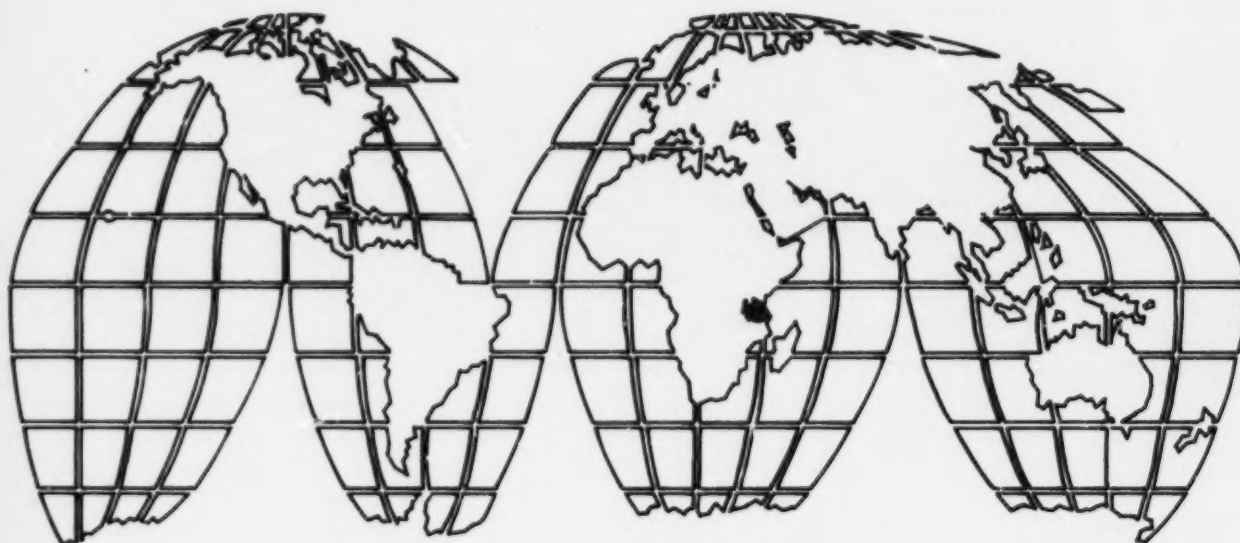
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A.I.D. Evaluation Special Study No. 3

**Rural Water Projects in Tanzania:
Technical, Social and Administrative Issues**

35



November 1980

Agency for International Development

PN-AAH-974

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RURAL WATER PROJECTS IN TANZANIA:
Technical, Social, and Administrative Issues

A.I.D. Evaluation Special Study No. 3

by

Daniel Dworkin

Office of Evaluation
Bureau for Program and Policy Coordination

U.S. Agency for International Development

November 1980

The views and interpretations expressed in this report are those of the author and should not be attributed to the Agency for International Development.

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Foreword

This report was prepared as part of an initial effort by the Office of Evaluation to examine the effectiveness of rural potable water projects assisted by A.I.D. Field research was conducted during the summer of 1979 by Daniel Dworkin with the assistance of Elliott Morss and Ross Hagan of Development Alternatives, Inc., in Tanzania and Ross Hagan in Kenya. The Kenya results, which include observation on the impact of A.I.D. projects, were published by this office under the Project Impact Evaluation series. Focusing on technical, administrative and financial viability issues of rural water systems in Tanzania, this study is useful for several reasons: it is based on field observation in one of the least developed countries which has made a serious commitment to provide safe water to its rural citizens, it examines the variety and appropriateness of the technological approaches for supplying water to rural areas, and it contains a number of findings and proposals worthy of serious consideration by foreign assistance donors and host country officials as they prepare to meet the challenge of delivering a basic human requirement: safe reliable water.

I. SUMMARY

AID is assisting the Government of Tanzania in providing improved water systems in rural areas. This study was carried out to help ensure that these efforts result in systems that work, are used, and provide benefits to the users. This report has three major lessons:

TECHNOLOGICAL LESSON

Shallow wells with handpumps are the most appropriate technology for supplying water in rural Tanzania. Shallow wells are more reliable, have a lower capital cost, and are the least expensive systems to operate.

Recommendation: USAID should specify the use of shallow wells with handpumps for village water projects in Tanzania.

SOCIAL LESSON

A number of systems in rural Tanzania are not functioning because of a shortage of funds to buy fuel or to replace worn parts. Most users would be willing to pay if the systems were perceived as useful and if the payments were equitable.

Recommendation: Users should pay the full costs of operating and maintaining the systems. Rural water projects should always incorporate a method for assessing users and collecting funds sufficient to cover operating and maintenance costs.

ADMINISTRATIVE LESSON

Some donors set up completely separate parallel organizations with offices physically separated from the office of the Regional Water Engineer who will eventually be responsible for the project. Without close coordination, successful continuation of the project will be less likely.

Recommendation: Those who plan projects should ensure that there is an integration of project activities and activities of the Regional Water Engineer.

The following sections of the report will show how we arrived at these conclusions and will make additional suggestions for developing projects for Tanzania.

II. THE STUDY

This evaluation of rural water projects in Tanzania took place over a six week period in July and August, 1979. The team for this evaluation consisted of three core members: Daniel Dworkin, a geographer with USAID; Elliott Morss, an economist with Development Alternatives; and Ross Hagen, an engineer with the same group. William Balalie, a hydrologist with the Ministry of Water, Energy, and Minerals (MAJI), was the head of the Tanzanian group that participated, which included Regional Water Engineers, interpreters, and support staff.

The team visited 20 villages that were selected after discussions with MAJI officials and donors. The main criteria for selection were: 1) that the systems were completed; 2) that they represented the technological diversity of rural water supply systems in the country; and 3) that they represented regions with different natural water resources.

The sites we visited represent the four major technologies in use in dry regions (Shinyanga and Singida), wet regions (Iringa and Mbeya), and mixed regions (Morogoro). We did not attempt to provide a statistically representative sample of the water program. At each site a standardized interview schedule was used to collect data. The group responding consisted of the village chairman or secretary, and a group of village elders. Women were not usually part of the group interviewed, but there were exceptions. A description of our field studies is contained in Appendix A.

The evaluation would not have been possible without the assistance of Mdugu Kassum, Minister of Water, Energy, and Minerals, whose staff provided vehicles and field support for the team. The Regional Water Engineers and their staffs, the village leaders, and elders also provided unstinting support. The evaluation effort would have been far less pleasant if the Australians of Snowy Mountain Engineering had not welcomed us in Singida and provided unlimited hospitality and professional support. Chartered aircraft and other travel expenses were funded by USAID.

III. THE SETTING

Developing, implementing, and administering a rural water system should ideally be based on conditions in each village that is served, rather than be imposed as a decision based on the small sample of villages chosen for this study. The history of past investments and the constraints imposed by climate, economics, and the institutions, however, are compelling arguments for the use of the simplest, least expensive technology. This section outlines the constraints on the technologies used to supply water in rural areas.

CLIMATE

Rainfall is a major factor in the choice of technology. The amount of rainfall the country receives varies widely from less than 500 millimeters to over 2000 millimeters as an annual average. Less than half the country receives an average of 750 millimeters or more, which is a minimum for productive agricultural use. Distribution is as important as the amount. In most of the country, rainfall is confined to two periods. Some lakes and surface storage areas dry out completely during the dry periods, only to fill and sometimes flood during the rains. The ground water level of some aquifers declines. The aquifers that are sources of water for shallow wells are particularly affected.

Streamflow varies with rainfall. Some streams dry up completely during the dry seasons while in others the flow is reduced. Flows during the rainy period are very high and frequently the supply intakes become silted or wash out.

During rainy periods, rural residents can collect water from a number of sources that are not available in dry periods. This is critical for planning water systems, since anticipated benefits frequently assume that the improved source of supply will be used exclusively. It is difficult to convince a rural resident to collect water from an improved source that is further than a traditional source close at hand.

Rainy periods may prevent delivery of fuel or spare parts, since some roads become impassable in the rainy season and bridges may wash out. During the evaluation, access to many of the areas in the country was not possible by road.

SETTLEMENT PATTERNS

The Government encourages rural people to resettle in villages. This policy makes it easier to provide people with an improved source of water, since a number of families can be served by each communal water source.

The village relocation program is proceeding. In mid-1977, 12 million people out of a total population of 14 million lived in 7300 villages. Projections are that by 1981, virtually all the 15.7 million people of the country will be living in 8000 communities.

Although there are advantages to supplying water to a grouped community rather than to a dispersed population, planners did not use availability of water as a criterion for village location. As a result, many villages have no convenient source of water.

GOVERNMENT POLICY

Government policy and Government actions conflict; the result is that the national program lacks financial support and is inconsistent in the technologies it uses and the obligations it puts on the communities. The following historical review of policies furnishes a perspective for understanding the present situation.

The policy of the Government in rural water supply has undergone a number of changes. The initial goal, set forth in the second development plan in 1969, was to provide water for everyone in rural areas within 40 years. In 1970, the time period was shortened and interim goals were set:

- to provide a source of clean and dependable water within a reasonable distance (less than 4 km) of each village by 1981 as a free basic service; and
- to provide a piped water supply in the rural areas by 1991 so that all people will have access to a public water supply within 400 meters.

By 1976 the emphasis had been changed. The Third Five-Year Development Plan (1976-1981) included the following guidelines:¹

- village water systems should consist of small and simple systems at low costs;
- various methods of water collection should be used, e.g., rainwater collection;
- suitable water lifting devices include handpumps and windmills;
- every 100 villagers will have at least one water source; and
- the village program is not primarily to provide piped water.

Recently the Government changed its policy in two ways: it dropped the 1981 interim goal that each village have at least one source of water; more significantly, it required users to pay for water. The 1991 goal still stands, although the requirement for piped supply conflicts with the 1976 guideline that states that the village program is not primarily to provide piped water.

This inconsistency would not be a problem if a central ministry controlled the formation and implementation of programs. In Tanzania

this is not the case. There are 20 regions, each with its own rural water program. In some of the regions, diesel-pumped water systems with extensive distribution networks are used for rural supply, while other regions rely on hand-dug shallow wells with handpumps. In some regions, users are asked to pay during periods of the year and in other regions they are never asked to contribute.

SYSTEM FUNDING

Present budgets fail to provide the level of funding necessary to maintain and operate the systems. In the Lake Regions, most of the systems have diesel pumps with large piped networks. The 1976-77 budget provided only 15 percent of the funds necessary to operate and maintain the system and to rehabilitate those systems that were not functioning. The funds were only sufficient to purchase fuel and oil.² As a result the systems are not functioning. Mr. Ndugu Kassum, Minister of Water, Energy, and Minerals (MAJI) announced in the National Assembly that 60 percent of the West Lakes systems needed rehabilitation.³

The year 1976 was a year of export growth. In other years when exports declined, the funds for the systems were even more restricted. The Government deliberately reduced the funds for imports of parts and fuel, even though it was aware that it would cause deterioration of rural water systems.⁴

In addition to MAJI, two other agencies fund projects for rural water supply: the Community Development Trust Fund (CDTF), a private donor organization, and the Regional Development Fund (RDF), a granting agency supported by the Government of Tanzania. WHO estimates that 1.5 million people are served by systems funded by these organizations.⁵

Ninety percent of the cost of the rural water supply development program is being financed by donors. The Swedish International Development Authority (SIDA) has been involved since 1965; through 1978 it has provided nearly \$50 million. Ten other countries and several multilateral donors (including IBRD, UNICEF, UNDP and WHO) have also provided assistance. The United States has included rural domestic water supply as part of its rangeland project and is now including water supply as part of the Arusha Integrated Rural Development Project. The data on specific assistance activity to 1978 is outlined in Appendix B.

PRESENT SITUATION

Estimates vary on the number of persons served by rural water supply systems. MAJI stated recently that 6.5 million persons, or 38 percent of the rural population, had "clean water."⁶ Presumably this includes the design population of all systems built in the country. Other estimates are lower. A recent report estimates that six MAJI schemes in rural areas have a design population of 4.5 million.⁷

Design population, however, differs from the actual population served because a system might not be operating or might not be serving the population for which it was planned. The same report estimates that three million persons were actually served from existing MAJI systems.

The lack of a national program has resulted in wide variation in projects. Complex technologies predominate in one region while simple systems are emphasized in another. Donors chose technologies on the basis of their interest and traditional approach, rather than on the most appropriate solutions for the physical and social setting. The guidelines of the Third Five-Year Development Plan have been almost completely ignored or contradicted. In Shinyanga, a rural water system means hand-dug shallow wells with Shinyanga handpumps. In Singida, with much the same physical and social setting, the technology used is predominantly deep wells with dual pumps: a windmill and a standby diesel unit. In Iringa, they emphasize gravity systems. Morogoro emphasizes hand-drilled shallow wells with kangaroo handpumps. Tanga is served by an extensive gravity pipeline. In the West Lakes area, systems are diesel-pumped. More details on particular water systems are in Appendix A.

IV. TECHNOLOGICAL ISSUES: THE CASE FOR SHALLOW WELLS

The evaluation sample included 20 villages, one with two different systems. In addition to the three donor projects, there were gravity systems, diesel systems, and shallow wells built by the Regional Water Engineers. In this section we present the comparative data on reliability and costs of the systems. Appendix A contains the field studies.

SYSTEM RELIABILITY

A rural water system should deliver water reliably. We chose as a measure of reliability the number of months in a year that water is actually available. The data we gathered are based on the statements of villagers, operators, and Regional Water Officials, since no operating logs are kept. We transformed their statements about the systems into approximate figures for the year, which are shown in Table 1. The data demonstrate that shallow wells and windmill/diesel systems are the most reliable systems, gravity systems are less reliable, and diesels are the least reliable.

Table 1

THE AVAILABILITY OF WATER IN DIFFERENT WATER SYSTEMS

<u>Region and Technology</u>	<u>Water Available Months Per Year</u>	<u>Region and Technology</u>	<u>Water Available Months Per Year</u>
Shinyanga		Singida	
Shallow Well	9.0	Shallow Well ^c	1.0
Shallow Well	11.7	Windmill/Diesel	12.0
Shallow Well	11.8	Windmill/Diesel	12.0
Shallow Well ^a	12.0	Diesel	5.0
Shallow Well	11.6		
Shallow Well	12.0	Mbeya	
		Gravity	9.0
Morogoro		Gravity	11.0
Shallow Well ^b	12.0	Gravity	10.0
Shallow Well ^b	12.0	Diesel	9.0
Gravity	9.0		
Diesel	10.5	Iringa	
Diesel	6.5	Gravity	12.0

a. This shallow well replaced a completely unreliable diesel system.

b. A project and nonproject system.

c. A MAJI system.

Five of the six villages with shallow wells in Shinyanga had water for more than 11.5 months during the year. Two of the Shinyanga villages had water the whole year and the other three villages were able to get water from the shallow wells for 50 weeks or more annually. One of the villages reported that water was not available for an average of three

months annually. The two villages in Morogoro served by shallow wells had water year-round. In Singida, the shallow well system built by the regional office of MAJI was not reliable.

The good record of reliability of the shallow well systems results from the use of multiple wells in a single community. The Shinyanga village with the unreliable system had a single shallow well. The unreliable Singida system was built by a Regional Water Engineer; two wells were constructed using the methods of the shallow wells project, but one was never furnished with a cover or handpump and the handpump on the other well separated from its base soon after installation.

The two windmills of the windmill/diesel systems were operating reliably; the problems were with the diesel engine. In one system the engine required and received frequent repair; the other engine worked, but the supply of diesel fuel was irregular. When funds were low, the regional officials asked the community to pay for the fuel, but now there is a dispute between them over whether the villagers did or did not pay for it.

The team investigated five gravity systems. Two furnished water on an average of more than 11 months each year; the other three were out of service for two months or more each year. They all failed in the rainy season when silt clogged the intake structures. Alternate sources are available during the rainy season, so the effect on the community was less than if the shortage had occurred during the dry period.

Diesel engines alone were used in five communities. None worked dependably. The most dependable diesel system was out of service an average of 1.5 months each year. One of the systems was out of service more than it operated. The reasons for the poor record include lack of fuel, poor system design, and poor maintenance.

CAPITAL COSTS

Estimated costs of water systems in the country range from Sh 80 to Sh 600 per person. Most of the estimates are from the reports of Regional Water Engineers for the period from 1970-1975, updated to 1976 by an inflation factor. Data for the shallow wells are from the records of the Shinyanga project.

Shallow wells have the lowest capital cost of any of the other technologies. Each well costs Sh 20,000, which includes all direct and indirect costs of construction. Since each well is intended to serve 250 people,⁸ it costs an average of Sh 80 for each person of the design population.

Windmill/diesel systems are the most expensive method of providing water for a community. The windmill and the diesel are separate systems each requiring a well. The only common elements are the water distribution system and the storage tank. The experience with installation of windmills has not been long enough to develop independent figures for the combination, but since a diesel-pumped well costs Sh 306 per capita and

since windmills are more expensive than a diesel engine, the costs will be over Sh 600 per capita.

The cost of a system using a diesel engine to power a pump depends on the cost of developing the source of water: building a dam or drilling a well. A diesel-powered well will cost approximately Sh 260 per capita. A diesel system using surface water costs about Sh 360 per capita.

Gravity systems cost an average of Sh 213 per capita; the major item in the cost is the piping. The systems need better designed and presumably more expensive intakes to prevent clogging during the rainy seasons.

OPERATING COSTS

Most of the capital costs for developing rural water systems have been provided by outside donors, but few are willing to provide funding for the continued operation of the system. These operation and maintenance costs are critical. The Government budgets of Tanzania have never provided adequate funds for the systems in place and, because of rapidly escalating costs, this may become an increasing problem.

Operating and maintenance costs are lowest for shallow wells and are closely followed by the costs of gravity systems. Pumped surface water and pumped wells which are predominantly diesel-powered are the most expensive to operate and maintain (Table 2). There is not enough experience with windmill/diesel systems to estimate costs.

Table 2

PER CAPITAL ANNUAL COSTS OF OPERATING AND MAINTAINING WATER SYSTEMS (\$US)

Type of System	Fuel and Lubricant	Spare Parts, Transport	Salaries to:		Total
			Maintain	Operate	
Shallow Well	-	.40	.26	-	.66
Gravity	-	.32	.26	.38	.96
Pumped Surface	.51	.63	.26	.38	1.78
Pumped Well	.51	.81	.26	.38	1.96

Source: World Health Organization/World Bank Cooperative Program, *United Republic of Tanzania Rural Water Supply Sector Study*, (Geneva, Jan. 1977), Second Draft Annex 9, pp. 23-28. No estimates are available for windmill/diesel units.

Any analysis of costs in Tanzania should consider whether these are incurred for labor, for fuel, or for imported or locally available materials. The fuels for pumped systems are all imported; the costs have more than doubled since the data were gathered in 1976. The spare parts of pumped systems are primarily imported and therefore require foreign

reserves. Shallow wells and gravity systems, on the other hand, require no fuel and fewer spare parts, which are also mostly of local manufacture. Thus if we were to update the costs of running the systems, diesel systems would appear even more expensive.

The economic message is clear. Where possible, Tanzania should concentrate on shallow wells and gravity systems. Where this is not possible, an approach not yet used in the country should be tried: hand-pumped deep wells as a substitute for power-driven deep wells.

SUMMARY OF TECHNOLOGICAL ISSUES

We have shown that shallow wells should be the first choice of technologies to serve rural Tanzania. They are the most reliable systems, they cost less to install and less to operate, they are labor intensive, and the materials they use are almost completely of local origin, which itself creates local employment.

The choice of shallow wells will become increasingly important as the costs of fuel to power diesel pumps and raw materials to fabricate PVC pipe become more expensive. Since both these items are imported, they affect the balance of payments, a perennial problem in Tanzania.

However, technology is only one factor in the success of rural water programs. It is important to integrate the technological choices with the social and administrative issues. In the following sections we discuss these two concerns.

V. SOCIAL ISSUES: WHY USERS SHOULD PAY FOR WATER

This section makes three points: there is a need for more funds for operating and maintaining rural water systems; the funds can be obtained from users, since they are able and willing to pay for water in the right circumstances; and users must be involved at some level in the water supply decision if payment systems are to succeed.

FUNDS ARE INADEQUATE

The present level of funding is inadequate to insure the continued operation of the rural systems. With the exception of the shallow well projects in Shinyanga and Morogoro, most systems are not working well. MAJI stated that 60 percent of the operating water schemes in the Lake Zone regions needed rehabilitation.⁹ A survey of water systems run by MAJI indicates water is provided on an average of only eight months out of the year in these regions. Two-thirds of the pump units there need replacement or require a complete overhaul.¹⁰

There is no effective organization to provide the maintenance even if funds were available. In the Mwanza region the capital costs of an

operating and maintenance system is estimated at Sh 4,275,000 and requires an additional Sh 500,000 for training. Only Sh 730,000 were available.¹¹

The problem in Mwanza is neither unique nor universal. In the regions covered by the evaluation--Shinyanga, Singida, and Morogoro--organizations that were set up for the projects can serve to maintain the water systems after the projects are completed. This has already happened in Shinyanga: the staff trained under the donor program is now operating under the direction of the Regional Water Engineer.

But even if the organizations were formed, the funds for operation and maintenance needs would not be available. In 1976, less than 60 percent of the funds for fuel and operators, and only 10 percent of funds required for maintenance, were provided.¹² During periods of financial crisis the Government cut back on the already low levels of funding, knowing that the restricted budgets would cause the rural water systems to deteriorate for lack of maintenance.¹³

The evaluation occurred during the war with Uganda; gasoline was not always available for the Regional Water Officials. The work of the wind-mill/diesel project in Singida was halted because of the shortage of fuel, although it was available in commercial service stations.

The problem of funding rural projects will continue to increase as more persons in rural areas have access to water. The amount required is always cumulative and each year's budget must be increased by the rate of inflation of costs of fuel, spare parts, vehicles, and other items required to keep systems operating. To ensure that money is available, the users must provide the necessary funding.

USERS ARE ABLE AND WILLING TO PAY FOR WATER

There is extensive evidence that users will pay for service if it meets their needs and if they consider the assessed rates to be fair. Most rural water systems in Latin America use the willingness to participate in the financing of a water supply as a major criterion for selecting villages to receive water supplies; in other areas of the world the willingness to participate is not considered as important.¹⁴ To provide the necessary funding, the Government should consider the willingness to contribute as an important criterion for selecting communities to receive improved supplies.

There are some problems in getting communities to pay for systems that are seen as Government choices rather than individual choices. Individuals who are asked to pay should be as deeply involved in the water supply decision as possible. The community should at least be aware of what will be done and should help develop the rate structure. Whenever possible, they should also be involved in choosing technologies and should be aware of the costs of the technology that they choose.

Users pay when they can perceive benefits from the improved supply. Of the 20 communities we visited, 16 perceive an improvement in health, three do not, and in one community the opinion is divided. Health

improvements are perceived even though some of the systems are unreliable and could provide few real health benefits. The communities also claim that the system improves productivity and provides more free time for the women.

USERS MUST BE INVOLVED IN A PAYMENT SYSTEM TO ENSURE SUCCESS

When users help to decide on a payment system it becomes a community agreement supported by the pressure of community residents. There are inevitable inequities in the service and use of water in a community. One person may live nearer, one may have more cattle, another may use water for minor irrigation. Community residents can adjust the rates for water to accommodate these concerns.

Some rate structures do not even depend on individual payments. One community used the profits from a cooperative grain mill to pay the necessary expenses. However, examples of successful payment systems are rare, while systems where users failed to pay are numerous.

The difficulty of raising funds for water is understandable. The Government provides the systems and in most instances no villager is asked to contribute. In the shallow well projects, installation labor is paid. When water systems are built by the Government, people naturally believe that the Government should pay for the operation. At times of economic austerity, when users are asked to pay, the questions of who pays how much then become important: should the fee be by use, by proximity to a communal facility, or by ability to pay? These questions are settled and adjusted more readily if an adequate rate structure is determined before any system is built.

VI. ADMINISTRATIVE ISSUES: THE CASE FOR INTEGRATING DONOR PROJECTS

Tanzania is not receiving all the possible benefits from donor programs because the activities of the Regional Water Engineers and the donor projects are not always closely integrated. There are three possible ways to provide integration: provide counterpart personnel who are trained in the methods and techniques of the project; periodically review and integrate activities of both donor and Regional Water Engineers to prevent duplication of efforts; and finally, to adopt or adapt the innovative methods of donor projects into the regional program.

THE NEED FOR TRAINED COUNTERPARTS

The regional authorities have not provided the number of counterpart technicians that were specified by any of the three donor projects. This represents a missed opportunity. It can affect both the current operation of the project, the spread of useful technology, and the future operation of the completed projects.

Projects are designed by donors and Tanzanians who often have a limited knowledge of the field conditions within the region. At an early stage a local counterpart technician could influence the project activities to reflect actual conditions rather than those that are assumed to exist. The person could provide bridges between the various groups that have an interest in the project: Regional Water Engineers, local suppliers, and beneficiaries.

Presumably the donor projects are designed to alter current practice in some way: modify the administration of water systems; introduce an innovative technology; or change the method of implementing a project. The counterparts can ensure that useful innovations will continue and, if appropriate, spread to other regions.

The counterpart personnel will be responsible for operating the project when the donor leaves. If the persons are not trained, the continued operation of the project may be impossible and the work will be wasted. As an example, in Singida the Australians are establishing stream-monitoring networks for previously unmeasured streams. At the conclusion of the project, Tanzanians will be responsible for the continued operation of the system--but without the skills for operating and maintaining the equipment, the system will become worthless. At the time of this evaluation there was no one who was available for training.

THE NEED FOR PROJECT REVIEW AND INTEGRATION

The Regional Water Engineer and the donor have a common objective: to provide rural villages with useful water systems. Duplication may result unless there is a periodic review to plan future activities. We saw both good and poor examples of review and integration. In Singida the Regional Water Engineer and the Australians meet periodically to discuss the project and there is also continual informal interchange. The Australians have become informal advisors to the vehicle maintenance facility and have a formal role in training mechanics. The interchange is made easier by the physical arrangement of the facilities: the Australian offices are in the same compound with those of the Regional Water Engineer.

The Morogoro region does not have the same close liaison. The compounds are physically separate and there is little interchange between the Regional Water Engineer and the head of the donor project, who plan and operate independently. As a result of this independence of action, a single village received three water systems--in a region where the majority of villages have none. The problems of this single community illustrate not only poor coordination, but also the point that we make in the next section on adoption of technology.

THE NEED TO ADOPT INNOVATIVE METHODS

The Regional Water Engineers should adopt those methods that are more suitable than those they currently use. Not all donor projects or methods are useful, but some are far better than existing practices.

For example, the method for building shallow wells that was originally part of the Shinyanga project has been improved and is being introduced in Morogoro. The Australians in Singida and the Americans in Arusha have also adopted this method. It is inexpensive, requires a minimum amount of material, provides local employment, requires few imported components, and takes less than three person-months to complete.

This is a more suitable technology than the standard shallow well built by the Regional Water Engineers: massive structures eight feet in diameter which require large amounts of cement and an average of 60 person-months to complete.

The Morogoro village cited earlier had a recent cholera outbreak and was a natural choice for an improved water system. One of the three systems it got included the type of well built by the Regional Water Engineer, which indicates that the local program has not incorporated the better methods developed by the donor.

In some cases the newer wells are not only easier to use, but safer. In the case of the project wells the pump is mounted at ground level. The others require climbing four steps to a raised platform to operate the pump. In addition, one of the imported pumps on the large shallow wells requires priming, which could allow the well to become polluted.

VII. OTHER ISSUES

This assessment has made three points: the situation requires simple technologies, users should pay for the operation of water systems, and donor projects and rural activities in the region should be closely integrated. There are three additional issues which are less significant for the overall operation of the rural water program, but which should nonetheless be considered by AID: the preparation of water master plans, the standardization of components of water supply systems, and the need for a different mix of vehicle types in the country.

WATER MASTER PLANS

Water master plans are studies of the availability, the need, and the plans to meet the needs for water for each region over an extended time period. These plans cost as much as Sh 35 million and take up to four years to complete. Preparing a water master plan requires that the following tasks be done:

- analyze existing data on water resources;
- compile data on withdrawing and using water;
- inventory existing domestic water supplies, describe their operating status, and devise a program for their rehabilitation, maintenance, and operation:

- project water use over 10-, 20-, and 30-year periods;
and
- devise a plan to complete and extend the data base.

Water master plans are essential when an area's water resources must be completely developed, as in most arid areas. Regional master plans could also be useful for national planning in Tanzania, but those that have been prepared to date are not compatible.

What would be useful is the part of the plan that assesses supplies, including both traditional and improved sources. In addition, a preliminary assessment of water supply potential should be synthesized from existing sources and secondary data. This assessment should evaluate the adequacy of the existing hydrological and meteorological monitoring methods and networks and should consider funding an improved and expanded system where necessary.

THE NEED FOR UNIFORMITY OF COMPONENTS

The rural water program in Tanzania is less effective than it could be because components of water systems are not uniform. The Singida project tried to use pumps that were available in the country, but when none were available, they introduced a different pump. This increased the complexity of maintenance. Diesel engines used for rural water systems are made by a number of different manufacturers. We encountered British, Italian, Indian and American diesel engines.

The same situation applies to almost all the components in water supply systems. It is difficult for the country to maintain adequate inventories of all makes and models of water components. The Government should assess the suitability of water system components, establish an approved list, and insist on compliance by donor agencies.

THE NEED FOR VEHICLES

MAJI is severely hampered by lack of vehicles. The country needs to greatly expand its fleet to carry out the necessary tasks of servicing and installing water systems.

The standard vehicle in use is a Land Rover assembled in the country. It has four-wheel drive and is suitable for all areas of the country, especially where other vehicles would get mired. However, the Land Rover is an expensive vehicle to buy and operate. MAJI officials spend a considerable amount of time traveling long distances on relatively well-maintained roads. For these trips, some thought could be given to selecting lighter vehicles that have far lower capital and operating costs.

VIII. Conclusion

There are three conditions that would ensure that rural water systems are and will continue to be successful in Tanzania. The technology must be simple, the funds for operation must be provided by the community served, and the donor project should be integrated with the activities of the regional water engineers.

The shallow wells projects in Shinyanga and Morogoro are both successful because the technology is particularly appropriate for the social and environmental conditions, but neither project has satisfactorily resolved the problem of local financing. Their continued success will depend on a satisfactory resolution of this problem.

The success of the shallow wells projects compared to the performance of other technologies suggests that, where possible, shallow wells should be the technological choice. With community support to assure their continued operation, these systems can serve much of the rural area of the country with a dependable supply of water at low cost.

BEST DOCUMENT AVAILABLE

NOTES

1. Government of Tanzania, *Third Five-Year Development Plan: 1976-1981* (1976).
2. Olle Rimér and Associates, "Current Water Supply Situation" (Stockholm: March 30, 1979), p. 9.
3. "Speech to the National Assembly July 9, 1979," *Daily News* (Dar es Salaam, July 10, 1979), p. 1.
4. R. Green, D. Rwegasira, and B. Jan Aokadie, *The Balance of Payments Adjustment Process on Developing Countries: The Case of the United Republic of Tanzania*, (UNB/UNCTAD Project INT/75/015, December 1978), p. 29-33.

James H. Weaver and Arne Anderson, "Stabilization and Development of the Tanzanian Economy in the 1970s," Brookings Institute Conference on Economic Stabilization Policies in Less Developed Countries (Oct. 25-26, 1979), p. 15.
5. World Health Organization/World Bank Cooperative Program, *The Tanzania Rural Water Supply Sector Study*, (Geneva, Jan. 1977), Vol. 1, p. 2.
6. "Speech to the National Assembly," p. 1.
7. Olle Rimér and Associates, "Terms of Reference for an Action Programme in the Water Supply Sector," Report submitted to the Swedish International Development Authority (March 30, 1979), p. 2.

World Bank, "Staff Appraisal Report Tanzania: Mwanza/Shinyanga Rural Development Project," (May, 1978).
8. DHV Consulting Engineers, *Shallow and Medium Depth Wells: Final Report* (Amersfoot, The Netherlands, n.d.), Part I, p. 91.
9. "Speech to the National Assembly," p. 1.
10. Rimér and Associates, "Current Water Supply Situation," p. 5.
11. *Ibid.*, p. 9.
12. *Ibid.*, p. 8.
13. See note 4.
14. C. S. Pineo and D. V. Subrahmanyam, *Community Water Supplies and Excreta Disposal Situation in Developing Countries: A Commentary*, (Geneva: World Health Organization, 1955).

APPENDIX A
FIELD STUDIES

APPENDIX A

FIELD STUDIES

The team visited a total of twenty villages for the evaluation, which covered all the technologies currently used in Tanzania: shallow wells, diesel-pumped systems, gravity systems, and windmill/diesel combinations. The team visited three projects funded by donors: a shallow wells project completed in Shinyanga (Case 1), one underway in Morogoro (Case 2), and a diesel/windmill system just starting in Singida (Case 3). Following the presentation of these three cases, we present information on gravity systems and diesel systems. Section IV, Technological Issues, compares the reliability and costs of the various systems.

CASE 1: SHINYANGA SHALLOW WELLS PROJECT

The Shinyanga shallow wells project was a joint project between Tanzania and the Netherlands, started in 1974. Its objectives were to:

- form a construction unit to build 700 shallow wells in two years;
- guide the construction program during a nine-month start-up period and for two years of construction; and
- train counterpart personnel to ensure continuation of the project.*

Shallow wells are common in the Shinyanga region, and throughout Tanzania. All are open wells where the user gets water with a rope and bucket. The new project provided sealed wells with handpumps. The project faced a number of delays from the start. Some of them resulted from poor support by the government while others resulted from poor implementation plans or from an expansion of the scope of work.

The Government failed to provide the promised number of qualified counterparts. It was difficult to get basic materials such as cement.

* DHV Consulting Engineers, *Shallow and Medium Depth Wells: Final Report* (Amersfoort, The Netherlands, n.d.), Part I, P. 14.

Finally, the first wells could not be completed because the pumps that were to be supplied by the government were not provided. As a result, the project manufactured pumps adapted from a Ugandan design. The pump used local materials with the exception of an imported valve assembly.

The project was intended to provide the technical assistance and materials to build the system, but to depend on local labor contributions in the actual construction. This plan did not prove possible, since people did not volunteer. Some of the reasons cited were: the community was not involved in the planning and did not understand what was going to happen; because of Government policy, people expected water as a free service; villages were either newly formed or newly expanded (under the Government program to relocate everyone in villages) and individuals were required to expend all their energies on new homes and schools; and finally, a system with handpumps was not considered modern.

Two approaches were used to combat this indifference. The first was to pay a wage for the local labor. This was Sh 5 (Tanzanian shillings) per day compared to a normal wage of Sh 15. The second involved the local community in the process of locating and maintaining the wells. When a community was involved and when the other early wells in the region proved that they provided a reliable source of water, a community would provide the necessary labor for its own projects.

CASE 2: MOROGORO SHALLOW WELL PROJECT

The Morogoro well project is a replication of the Shinyanga project with a few exceptions. It was funded in 1978 by a joint agreement between Tanzania and the Netherlands. The goal of the project is the construction of 550 wells at the rate of 20 wells monthly over a three-year period. A project headquarters was constructed to build all the components necessary for the wells. As in Shinyanga, the project provides all the services necessary for administration, installation, and maintenance. There are two differences between the Morogoro and Shinyanga project: the type of well construction and the pump.

In Morogoro, wells are excavated by using a hand auger rather than by hand digging. This makes it possible to use a smaller diameter hole and thus smaller concrete rings for lining. The smaller well is feasible because the aquifers in Morogoro provide more water than those in Shinyanga. The reservoir of water provided by a larger diameter well is not necessary.

The pump used in Morogoro is also different. Although the internal mechanism is the same as used in Shinyanga, the superstructure is completely different: there is no handle. Water is pumped by stepping on a footrest welded to the base of a shaft. Eliminating the pump handle has decreased the cost of the pump. The designer expects the new "kangaroo" pump to be more reliable than the Shinyanga model, although not enough have been installed to make definitive judgements.

As in Shinyanga, the Morogoro project hires local labor to do the construction work. Workers are paid Sh 7 daily--higher than in Shinyanga, but less than the standard wage. People welcome the work, although it is

not clear if enthusiasm results from the contribution to community welfare or from the opportunity for employment.

Both shallow well projects are successful. Shinyanga has been completed and is being completely run by Tanzanian personnel. Morogoro has just started installing wells, which should also succeed, since the technology and methods are similar and the aquifers are more suitable.

In contrast, shallow wells built by the Regional Water Engineer (not as a part of the two projects) were either more expensive or did not work. In one of the installations the problem was design and in another the problem was construction. Both cases are outlined in detail in later sections.

CASE 3: SINGIDA WINDMILL/DIESEL PROJECT

The Singida windmill/diesel project is a joint project between Tanzania and Australia, started in 1975. The purpose of the project is to provide water for people and livestock. Water is obtained from deep wells and pumped primarily by windmills. Wind velocity is sufficient to power the windmills for an average of nine months annually: those which correspond to the dry months of the year. When wind is not sufficient a diesel engine drives a pump on an additional well. Both wells deliver water to an elevated tank with a short pipeline leading to communal taps.

The single well providing water for livestock is located away from the village, and is pumped by a windmill. During the rainy season, when there is insufficient wind, there are alternative sources for water for livestock.

The windmills are considered desirable because they are reliable, require less maintenance than diesel pumps, and operate without fuel. The useful life of a windmill in Australia is up to 80 years. The only routine maintenance is a semiannual inspection and an oil change every five years.

To ensure the continued operation of the project, the Australians have started a school to teach operators and mechanics. As part of the school the project is building a model village, served by a windmill and a diesel engine, that will house the students and provide practical experience with operation and maintenance.

There have been problems with the project: drilling rigs are unsuitable; spare parts and basic materials difficult to obtain; Government counterparts have not been provided; and windmill towers have been vandalized.

Schramm drilling rigs are the standard drilling machines used in Tanzania. The government has a large surplus and insists on using them for all substantial drilling projects. The Australians consider them a poor choice for the conditions encountered in Singida. They also find that the rigs are not well maintained. To use the rigs, the Australians

had to set up a maintenance facility, which was later expanded to provide maintenance for all the Schramm drilling rigs in the country.

The project had problems getting a sufficiently uniform supply of pumps for the diesel-driven wells; for the variety of pumps that they could obtain, spare parts were not always available. Finally, the project staff decided to import Australian pumps and spare parts.

Other basic supplies are sometimes difficult to get. When the project needs cement, a truck is dispatched to Dar es Salaam, where the driver waits until he is assigned a load. The lack of an assured supply of cement has slowed the progress of the project. During the period when the team was in Singida, all project activities stopped because there was no fuel to operate the vehicles or drilling rigs.

Windmills, which are so dependable in Australia, were threatened in Singida by persons who removed the bolts supporting the tower. Each windmill is now surrounded by a chainlink fence topped with barbed wire.

The slow pace of the project is disappointing to the Australians. To speed up the project, a program to build shallow wells on the Shinyanga model began in July 1979. Although this supplementary effort is considered only as a stopgap measure, this simpler technology may prove to be a more reliable source of water for Singida.

CASE 4: GRAVITY SYSTEMS

Gravity systems are being planned as part of a donor project in Iringa. At the time of the evaluation, the project had not started. We did see gravity systems serving villages in three regions: Iringa, Mbeya, and Morogoro.

CASE 5: DIESEL SYSTEMS

Diesel engines are parts of systems that pump water for surface sources, shallow wells, and deep wells; we encountered them in every region. The diesel engines we saw were manufactured in India, England, and Italy. Problems with diesel engines include poor installation, poorly trained operators and maintenance staff, lack of spare parts, and an uncertain supply of fuel.

APPENDIX B

BILATERAL ASSISTANCE TO THE RURAL WATER SUPPLY SECTOR

TANZANIA
RURAL WATER SUPPLY SECTOR STUDY
BILATERAL ASSISTANCE TO THE RURAL WATER SUPPLY SECTOR

APPENDIX B

(Source UNDP)

PROJECT/ACTIVITY (Title)	SOURCE	ASSISTANCE COMMITTED US\$ EQUIVALENT	DURATION	NATURE OF ASSISTANCE
1. Rural Water Development	Sweden	45 302 670	1965-1976	Comprehensive program including substantial technical assistance through experts and volunteers
2. Master Water Plans for Mwanza Region Mara Region West Lake Region	Sweden	2 733 500	1975-1978	Consultancy services
3. Master Water Plans for Mtwara Region Lindi Region	Finland	4 600 000	1972-1977	Consultancy services
4. Water Engineering	Finland	100 000	1973-1975	Two water engineers at MAJI
5. Water Engineering	Finland	90 000	1975-1977	One water chemist and one senior water technician in MAJI
6. Master Water Plans for Coast Region Dar es Salaam Region	Canada	2 700 000	1975-1979	Consultancy services
7. Master Water Plan for Tanga Region	F.R.Germany	2 115 300	1974-1976	Consultancy services
8. Water Development	F.R.Germany	1 233 500	1972-1976	Two drilling rigs and drilling experts in Tanga and Coast Regions
9. Rural Water Development	F.R.Germany	6 938 000	1974-1978	Construction of Handeni trunk main
10. Extension of Hydrological network in Kigoma Region Tabora Region Mbeya Region Rukwa Region Ruhuma	Norway	1 600 000	1973-1978	Construction and equipping of hydrological stations
11. Extension of Hydrological network	Norway	296 000	1973-1978	Eight experts to assist in the implementation of item 10
12. Rural Water Resources Project in the Singida Region	Australia	1 500 000	1974-1976	Provision of two drilling rigs with accessories and support vehicles together with a team of Australian experts
13. Water Supply Development Shinyanga Region	Netherlands	900 000	1974-1977	Sinking of 700 shallow wells, equipment, fellowship and 10 experts
14. Water Master Plan for Morogoro Region	Netherlands	19 000	1975	Assisting in formulation of terms of reference
15. Assistance to MAJI	Netherlands	55 000	1973-1975	One expert as Director of Construction Division, MAJI
16. Water Supply	Hungary	Not available	1975-1977	Seven water engineers to MAJI
17. Water Supply	Hungary		1973-1975	Five 3-year scholarships in water engineering in Hungary
18. Water Engineering Education	Hungary		1974-1975	Five scholarships in water engineering in Hungary
19. Assistance to Water	Pakistan		1975	A number of civil engineers to MAJI
20. Water Development	China			Provision of rural water supplies (number not available)
21. Training	India			Provision of 4-year university course for water engineers
22. Water Engineering	India			129 students started 1975; 30 students started 1976 Technical assistance/87 engineers and senior technicians are currently working in MAJI

APPENDIX B

APPENDIX C
REQUIREMENTS FOR USAID/T POTABLE WATER PROJECT

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REQUIREMENTS FOR USAID/T POTABLE WATER PROJECT

The purpose of this report is to detail the requirement for a USAID/T potable water project as a component of an on-going Arusha Planning and Village Development Project.

For further details in design and methodology see "Arusha Planning and Village Development Project," (Project Paper No. 621-0143), July 1978.

The following report is also the field summary left with USAID/T at the conclusion of the evaluation:

In Arusha Region, the project should concentrate only on selected aspects of the water master plan, leaving other tasks for future assessment and decision. The initial phase should concentrate on the collection of data for existing village supplies and a preliminary assessment of the water resource potential. This should be done through secondary sources and short visits to potential village sites.

The personnel needed to carry out these tasks include:

<u>Job Description</u>	<u>Nationality</u>	<u>Period</u>
Hydrogeologist	U.S.	1 year
Hydrogeologist	Tanzanian	1 year
2 survey personnel	Tanzanian	1 year

Wells Program

An organization capable of installing 20 village wells monthly should be provided. With an ultimate objective of installing 750 shallow wells, an investment of approximately Sh 4,000,000 would be required. Specific items to be funded would include:

Vehicles and vehicle workshop equipment	Sh 1,500,000
Concrete rings, covers and pump factory	150,000
Survey and laboratory equipment	1,000,000
Well construction equipment	1,000,000
Pump installation and maintenance equipment	7,000
Office and buildings	500,000
Administration, stores, miscellaneous	15,000
	Sh 4,172,000

Personnel requirements are:

<u>Job Description</u>	<u>Nationality</u>
Project Manager	U.S.
Hydrogeological staff:	
1 Hydrogeologist	U.S.
1 Hydrogeologist	Tanzanian
3 Surveyors	Tanzanian
3 Helpers	Tanzanian
Production Section:	
1 Supply Officer	Tanzanian
1 Concrete Factory Foreman	Tanzanian
1 Pump Factory Foreman	Tanzanian
1 Filter Construction Foreman	Tanzanian
1 General Workshop Foreman	Tanzanian
1 Production Supervisor	Tanzanian
1 Welder	Tanzanian
2 Plumbers	Tanzanian
8 Helpers	Tanzanian
Transport and Mechanical Section:	
1 Transport Supervisor	Tanzanian
1 Transport Clerk	Tanzanian
1 Helper	Tanzanian
30 Drivers	Tanzanian
6 Vehicle Workshop	Tanzanian
13 General Maintenance	Tanzanian
Administration:	
1 Administration Supervisor	Tanzanian
2 Administration Clerks	Tanzanian
1 Stores Supervisor	Tanzanian
9 Stores Clerks	Tanzanian
3 Helpers	Tanzanian

In addition to the fixed investment costs, a shallow wells program would require an operating budget of Sh 360,000 annually which would produce 40 operating wells monthly. This is exclusive of expatriate staff and government personnel. Before making such a large capital investment, one year might be spent testing the technology and village acceptance of the pump. Assuming 40 wells would be dug and 40 pumps purchased and installed in the first year the costs would be:

1 Survey Set	Sh 26,200
Materials	240,000
40 Kangaroo Pumps	116,000
Overhead	60,000
Transport	<u>250,000</u>
	Sh 692,000

Health Education

There are two possible health components to a rural water project: preventative and curative. A preventative health education component should be planned by a consultant after a brief village-level survey of current sanitation practices. If a program appears warranted, it should be designed for school groups of all ages, the adult community, and women and parents groups. Using the same survey, a curative program to assist health delivery personnel in the recognition and treatment of water-related disease prevalent in the region could be designed.

Implementation of this program will be under the direction of rural development specialists who will coordinate activities with appropriate village, district, and regional level personnel.

<u>Personnel Requirements</u>	<u>Nationality</u>	<u>Period</u>
Health Education Specialist	U.S.	1 year

Laundry Facilities

A suitable area for clothes washing should be provided within 10m of the water source. The facility should consist of a well-drained standing area with a number of simple water containment devices (tubs) with drains. One tub should be provided for each ten families. Tubs should be made of concrete or other durable low cost material. Drainage should be designed so that the waste water will be directed away from the water source and so that no standing water will persist.

Bathing Facilities

Simple enclosures for men and women with well-drained standing areas and drains for waste water should be built within 25m of the water source. Care should be taken to direct drainage away from the water source and to avoid standing water.

SPECIAL STUDIES

- No. 1: The Socio-Economic Context of Fuelwood Use in Small Rural Communities (August 1980)
- No. 2: Water Supply and Diarrhea: Guatemala Revisited (August 1980)
- No. 3: Rural Water Projects in Tanzania: Technical, Social, and Administrative Issues (November 1980)

PROGRAM DESIGN AND EVALUATION METHODS

Manager's Guide to Data Collection (November 1979)